SEMPEO214

# Preparing and proving CNC machine tool programs

## Overview

This standard covers a broad range of basic computer numerical control (CNC) programming competences that will prepare you for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment.

You will be required to produce the component program, using manual data input or by use of a remote computer, saving the prepared program on to a storage device or by downloading it into the machine controller from the computer.

You will be expected to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes, and to use repetitive programs and canned cycles, to reduce program size and input time. You will prepare component programs that combine a number of different operations, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, flat, square and parallel faces, angular faces, slots and recesses, special forms and profiles.

You will need to check the program using single block run and program edit facilities. You will also be required to adjust the machine tool equipment and program, following proving/editing procedures, to achieve component specification. You must ensure that any edited programs are saved safely and correctly.

Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the programming activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the programming activities, and to seek appropriate help and advice in determining and implementing a suitable solution. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you produce.

Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate CNC programming and proving techniques safely. You will understand the CNC programming process, and its application, and will know about the machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the programming activities to the required

specification.

You will understand the safety precautions required when working with the CNC machines, and with their associated tools and equipment. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself and others in the workplace.

**Specific Standard Requirements**

In order to prove your ability to produce programs that combine different features, at least one of the programs produced must be of a significant nature, and must cover a minimum of **five** of the features listed in scope 5.

## Performance criteria

*You must be able to:*

1. work safely at all times, complying with health and safety legislation, regulations, directives and other relevant guidelines
2. plan the programming activities before you start them
3. determine an operational sequence that avoids wasted tool/cutter movements and tool changes
4. develop component programs using appropriate programming codes and techniques
5. specify positional information and machine axes that are consistent with the requirements of each stage/operation
6. load/input the program to the machine controller, and check/prove the program for errors using approved procedures
7. save and store the program in line with organisational procedures
8. deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve
9. shut down the equipment to a safe condition on completion of the programming activities

## Knowledge and understanding

*You need to know and understand:*

1. the safe working practices and procedures to be followed when developing and proving CNC machine tool programs
2. the hazards associated with using CNC machine tools (such as automatic machine operations, power operated chucks, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised
3. the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area clean and tidy
4. the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
5. the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)
6. how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
7. how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
8. how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing
9. the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)
10. how to prepare part programs (using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes)
11. the use of features that enable reductions in program size and input time (such as canned cycles, subroutines and labels)
12. the function keys and operating system of the machine computer control system being operated
13. how to set machine datums for each of the machine axes being used
14. how to set the machine control system in the programming and editing mode, download (input) and upload (output) modes
15. how to deal with error messages and faults on the program or equipment
16. how to access the program edit facility, in order to enter tooling data (such as

tool datums, positions, lengths, offsets and radius compensation)
17. the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program
18. how to conduct trial runs (using single block run, dry run and feed and spindle speed override controls)
19. factors that may affect the feeds and spindle speeds being used, and why they may need to be adjusted from the programmed values (such as condition of material, workholding method, tooling used, tolerance and finish to be achieved)
20. the checks to be made before allowing the CNC machine to operate in full program run mode
21. how to save the completed programs in the appropriate format, and the need to store programs and storage devices safely and correctly, away from contaminants and possible corruption
22. typical problems that can occur with the programming, loading and editing activities, and what to do if they occur
23. the methods and procedures used to minimise the chances of infecting a computer with a virus
24. the implications if the computer you are using does become infected with a virus and who to contact if it does occur
25. when to act on your own initiative and when to seek help and advice from others
26. the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine and removing and disposing of waste)

## Scope/range related to performance criteria

1.

Ensure that you apply **all** of the following checks and practices at all times during the programming activities:

1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.2 the correct component drawings are obtained and checked for currency and validity
1.3 the appropriate reference manuals and programming codes are used to suit the machine controller
1.4 the machine controller is prepared ready to accept the operating program
1.5 the prepared program is input/loaded into the controller safely and correctly
1.6 programs are stored safely and correctly in the appropriate format
1.7 program media is stored safely and correctly, away from contaminants and corruption

2.

Prepare and prove programs for **one** of the following types of CNC machine tool:

2.1 two axis machine
2.2 multiple axis machines (5 or more)
2.3 three axis machine
2.4 machining centres

3.

Produce CNC programs using **one** of the following methods:

3.1 entered directly into the machine controller
3.2 using computer software

4.

Develop part programs which contain **all** of the following, as applicable to the machine type:

4.1 all necessary positional information
4.2 appropriate codes
4.3 machine management commands (preparatory/auxiliary functions)
4.4 repetitions within programs (using features such as subroutines, canned cycles, labels)
4.5 absolute or incremental co-ordinates
4.6 tool/cutter change positions
4.7 tool information (such as lengths, offsets, radius compensation)

5.

Develop programs to produce components which cover **eight** of the following features:

5.1 parallel diameters

5.2 angular faces
5.3 enclosed slots/recesses
5.4 stepped diameters
5.5 internal profiles
5.6 open ended slots
5.7 tapered diameters
5.8 external profiles
5.9 eccentric diameters
5.10 flat faces
5.11 reamed holes
5.12 external screw threads
5.13 internal undercuts
5.14 tapped holes
5.15 internal screw threads
5.16 external undercuts
5.17 drilled holes
5.18 chamfers and radii
5.19 steps/shoulders
5.20 holes on pitched circles
5.21 bored holes
5.22 parallel faces
5.23 holes linearly pitched
5.24 special forms (such as concave, convex)
5.25 faces that are square to each other
5.26 parting-off

6.

Develop part programs to machine components made from **two** of the following types of material:

6.1 low carbon/mild steel
6.2 cast iron
6.3 plastic/nylon/composite
6.4 high carbon steel
6.5 brass/brass alloys
6.6 aluminium/aluminium alloys
6.7 other specific material

7.

Prove the part program using **six** of the following:

7.1 single block mode
7.2 graphic displays/modelling
7.3 data input facilities
7.4 full dry run (in air)
7.5 search facilities
7.6 edit facilities
7.7 program override controls (spindle speed, feed rate, tool data)
7.8 program save/store facilities

8.

Confirm that the program operates safely and correctly, by checking **all** of the following:

8.1 datums for each machine axis are set in relation to all equipment and tooling used
8.2 all operations are carried out to the program co-ordinates
8.3 tool change positions are safe and clear of the workpiece and machine equipment
8.4 the correct tools are selected at the appropriate points in the program
8.5 tool offsets are correctly entered into the machine controller
8.6 tool cutter paths are executed safely and correctly
8.7 auxiliary functions operate at the correct point in the program (cutter start/stop, coolant flow)
8.8 programs have been saved in the appropriate format

## Behaviours

# Additional Information

You will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as:

- strong work ethic
- positive attitude
- team player
- dependability
- responsibility
- honesty
- integrity
- motivation
- commitment

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